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THE ECONOMIC IMPORTANCE OF THE SCIENTIFIC WORK OF THE GOVERNMENT. III

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MANY other examples of the economic importance of scientific research and standardization could be cited, if time permitted. The metallurgical industries have been greatly developed in recent years through scientific research, and there is now greater activity than ever in this field. The metallurgical division of the Bureau of Standards works in close cooperation with the engineering societies and manufacturers, and is doing work of very great industrial importance. The manufacture of glass, porcelain, tile, and other clay products has been greatly stimulated during the war by the cooperation of scientific laboratories, and vast benefit would be derived by these industries if this cooperation could be continued and even increased. The measurement of temperatures and especially high temperatures is a problem of continually increasing importance in the industries, and many scientific investigations are continually arising in this connection. The intelligent and efficient development of aeronautics depends on the possession of full and reliable information as to the properties of materials, the accurate measurement of the performance of machines, experimental researches in mechanics and aerodynamics, and the most intelligent utilization of existing and newly developed information. Considering the amount of money that is being expended in the development of aeronautics, it would seem that a very considerable amount should go into scientific research. The measurement of color and of illumination and of the optical properties of materials and the development of optical methods and instruments form together a field of investigation of great scientific and economic value. It is impossible even to mention all the subjects of importance in this connection, but enough has been said to show how vast the field and how practical the results that are obtained whenever science is appealed to in answering the problems arising in the industries.

RESEARCH BY LARGE CORPORATIONS

The Standard Oil Company has attained a wonderful reputation for its technical and commercial success in deriving valuable products from petroleum, a result which could never have been reached without extensive scientific research.

The General Electric Company has achieved notable success in the development of electrical instruments and machinery, electric lamps, steam turbines, the applications of electricity to ship propulsion, etc., and a very large part of this success may be credited to its scientific and development work. Its research laboratories have turned out many valuable contributions to science, in addition to the results of direct application in their business. The American Telephone and Telegraph Company, and its subsidiary, the Western Electric Company, have achieved a world-wide reputation for their development of long distance telephony, multiplex telephony and telegraphy and radio telephony, as well as for the development of many of the engineering features of telephone practise of the present day.

These and other great corporations carry on research work on a generous scale and derive great commercial advantage therefrom. But thousands of smaller companies can not do what they do. The smaller companies are, however, rendering the public a service that is very essential, and the public will serve itself by helping them to improve this service. This does not mean that they will have their burdens carried for them by the government, but rather that the government as the agent of the public should participate in research and standardization work (in cooperation with manufacturers' associations and engineering societies) in order that the public may be better served and in order that the public may judge more intelligently of the quality of the product or the service rendered. It is the open door method of doing business as opposed to the method of keeping the government and the public in partial ignorance. The burden of this work when borne by over a hundred million people is very light; the benefits far outweigh the cost. The American Telephone and Telegraph Company's research laboratories employ more research workers in their single field of investigation than the Bureau of Standards does for all its many lines of work for all the industries of the country. The results obtained justify the large expense for research in the telephone field. The splendid results obtained are not due merely to the fact that the work is well managed and is done by a great corporation; but rather to the fact that abundant resources (provided by the public) are made available and an adequate scale of salaries is paid. Government laboratories could do as well if they had an equal or nearly equal chance; but they can not work miracles.

THE ECONOMIC VALUE OF STANDARDIZATION

The American Engineering Standards Committee has recently been formed to promote engineering and industrial standardization. Five engineering societies and three departments of the government were represented initially in its membership. Several additional member societies have just been added and others will be added from time to time. The Committee is already actively at work in selecting sponsor societies for standardization work and approving standards. The government is rendering a valuable service to the industries, and thus to the people, by cooperating actively in this constructive and useful work. Manufacturers have not cooperated with one another in the past in standardizing designs as much as they could have done if there had been some practicable way of cooperating. They have resented government dictation and control, but they welcome government cooperation in constructive work that benefits both them and the public. In many cases the designs and sizes of machines and materials manufactured by different concerns are different because development has been independent. In other cases it is in order to have something upon which to base a claim of superiority. In either case, too many sizes and designs and lack of interchangeability increase the cost to the manufacturer, to the distributor and to the user. Nothing promotes economy and efficiency in the use of raw materials and finished products more than intelligent standardization. It reduces the varieties and sizes of materials that must be supplied by the manufacturer, lessens the stocks that must be carried by the distributor, makes the cost of the finished product less and reduces the trouble and expense to the user in caring for and keeping in repair machinery and equipment of all kinds. The high cost of the services of the plumber have been proverbial for years. Standardization in plumbing fixtures and fittings, and interchangeability of parts could be carried further than it has been. This would greatly reduce the charges for time and material in making repairs as well as in the original installation. The enormous and confusing variety of lighting fixtures, and the bad design of many, are due to utter lack of standardization or cooperation of the manufacturers with one another. Inefficient and dangerous gas appliances have been sold to the public for years, and many are still in use. The manufacturers can not be blamed, for they can not separately engage in expensive research to arrive at correct designs. The only practicable way is for all to cooperate and for the government to take an active part, helping the manufacturers to study these problems of design and standardization intelligently and thoroughly. Manufacturers are glad to cooperate in such work. Since the war particularly, the high cost of labor and material have shown the necessity for economy and increased efficiency, and manufacturers are welcoming the assistance of the government as never before.

THE DUTY AND OPPORTUNITY OF THE GOVERNMENT

Such work is constructive and wealth producing, and yields returns a hundredfold upon the investment. The benefit is almost immediate and not only are there material returns in decreased costs and improved service, but such cooperation between the government and the industries is helpful both to the government and to the industries, and raises the standards of business. It emphasizes good quality and good performance and good service, and reduces misrepresentation and exaggeration in selling. Is it not the duty of the government to cooperate more actively in this constructive way with the industries? No other agency can perform this important function. The government would do only a part of the work, but that part is of great importance. Engineering societies, manufacturers' organizations, and individual manufacturing companies will do their part, and in many cases the greater part. But if the government refuses to do its part on the ground that it would increase taxation, the public will not be satisfied with the reason given when it knows that at the present time out of $50 per capita per annum collected by the government for all purposes, *scarcely more than one cent per capita per annum is expended by the government for this important work, and five cents per year per capita would accomplish wonders*. The matter is of so fundamental importance, and promises results of so great economic and social value, that it is to be hoped that some more adequate effort along this line may be made. It seems impossible that such effort would not succeed at least in part, and even a partial success would more than repay the cost.

The English Journal previously quoted says this of the government's part in scientific research. "*The endowment of research and the financing of scientific investigation are essential in any progressive nation, and if the money is well spent no amount allocated to these branches can be too great at the present stage in our country's history.*"

In Great Britain the Engineering Standards Committee is largely financed by the government, while the Department of Scientific and Industrial Research is a government body financed entirely by the government. The American Engineering Standards Committee and the National Research Council (of America) are financed entirely without government aid. This is an additional reason why government research institutions in America should be so well supported that they can do their full duty in cooperation with privately supported scientific and industrial institutions which are doing work in the interest of the public.

GOVERNMENT LABORATORIES AND THEIR TRAINED PERSONNEL AVAILABLE FOR WAR

The war called for scientific research in connection with the standardization and making of munitions, finding and using substitute materials, locating enemy guns by sound and flash ranging, locating submarines, building and equipping ships and submarines, building and equipping airplanes, dirigibles and balloons, and many other major subjects as well as countless minor ones. This called for well-equipped scientific laboratories and the trained personnel of research workers and assistants. The government laboratories were utilized to the limit of their capacity, and all kinds of makeshift facilities were pressed into service. If preparations had been begun several years before, it is needless to say results would have been obtained sooner and the war appreciably shortened. In view of this experience, and the probability that science and technology will be no less important in the future than in the past, the question naturally arises whether the government is making adequate preparation for scientific research as a part of its program of military preparedness? In time of war the civil branches of the government will be called upon immediately for service, and they will be able to render invaluable service if they are adequately equipped and manned. In the meantime, pending the arrival of the war, which we hope will never come, they will be able to render useful service in civil problems and so be more than self-supporting. This kind of preparation for war, which adds nothing to the military budget if the civil departments are adequately supported, should appeal to all as practicable and desirable.

SUMMARY OF THE ARGUMENT

The federal government having emerged from participation in the world war, finds itself with a large debt and heavy annual charges caused by the war. These together with the current cost of the army and navy amount for the present fiscal year to 92.8 per cent of the total budget. The cost of public works and the necessary administrative cost of the federal government amounts to 6.2 per cent of the total. There remains one per cent for a large number of governmental activities classed as research, educational and developmental. The question arises whether in the interest of economy and efficiency the one per cent. shall be decreased; or because this work is constructive and of great economic value it should be increased, possibly doubled. The arguments in favor of increasing it may be summarized as follows:

1. The government should be constructive and helpful to the people and to business wherever possible. It should develop the industries, assist in improving commercial and industrial methods, and furnish technical information to manufacturers and others, as well as develop agriculture and the public domain. By rendering such service the government tends to establish good relations with business, to elevate business methods, to increase efficiency and to educate in many ways large sections of the public. The many services thus rendered cost very little in the aggregate as compared with the total expense of the government, but they are of great practical value and are appreciated by the people. *One per cent of the total expenses of the government spent in this constructive way seems a very small proportion in view of the wide range and the economic value of such work.*

2. But a part of this one per cent is incurred in behalf of the government itself, to enable the government to purchase its supplies intelligently and to do business in a business-like way. Without this research and testing work the government would waste more in buying than it would save by eliminating the research and testing. Making purchases without full technical information is embarrassing to public officials and unsatisfactory to business; whereas by always using intelligently drawn specifications and making adequate tests, the government can save money, elevate its own service and improve business methods. Much but not enough of this kind of work is now done. It is the duty of the government to set a good example before the business world of efficient and intelligent methods and fair dealing; neither accepting goods below the specified quality nor demanding more than is specified. *The government would spend less for its purchases if it spent more in standardizing the products purchased and in testing deliveries systematically.*

3. But apart from the service the government can render its citizens, and the benefit to the state resulting from scientific, educational, and developmental work, and apart from the benefit to the government of having the results of such work in constructing buildings and other public works, and carry-

ing on its business, this kind of work develops wealth, and the increased wealth can be taxed, and hence there is a third reason for increasing such work. The war has made it necessary to raise many times the revenue formerly required, and the taxation is now an important issue. Economizing in the use of raw materials, using cheaper materials, reducing waste, developing the public domain, increasing manufacturing efficiency, reducing distribution costs, all tend to create wealth and to make it easier for the government to raise the needed revenue. Therefore, if there were no other reason, this consideration should appeal to legislators and business men alike; *namely, that research and development work by the government develop wealth, and the burden of taxation is thereby lightened.*

4. But there is another powerful economic reason for increasing the productive developmental work of the government. The rising cost of living not only leads to hardship and distress, but to industrial unrest, strikes, disorders and great economic losses to the nation. In order to check rising prices, and if possible bring down prices, it will be necessary to increase production. To do this it is necessary to reduce waste and increase efficiency. This requires greater intelligence and fuller knowledge, and calls for education, the results of scientific investigation and of intelligent and extensive industrial research. The government could not and should not do it all. But neither should it refuse to do its part, and its part often is to take the lead in a constructive and statesmanlike way. It is stupid and blind to think that because taxes are heavy we can not afford to do things intelligently. If a farmer's barn burns down, he would not sell half his supply of seed and fertilizer to buy lumber, and then plant only half a crop. He would, if necessary, borrow money to buy more seed and plant a larger crop than usual, in order to increase his income and pay for the new barn more easily. *Intelligent research by the government, in cooperation with the industries, is like seed and fertilizer to a farmer. It stimulates production and increases wealth, and pays for itself many fold. It is as productive and profitable in peace as in war.*

5. Finally, if the reasons already adduced are not sufficient, there remains the military reason. The development of our intellectual, moral and material resources is the best preparation for war. Food and manufacturing facilities, and adequate supplies of raw materials and transportation systems and scientific attainments and the equipment and trained personnel available for military research, these together with an

intelligent citizenry and a just cause are the best preparation for war. A standing army and fleets of battleships are necessary but not a sufficient preparation, even if the army is armed to the teeth and the battleships are the heaviest or the swiftest in the world. The Great War demonstrated that modern wars are not of armies but of peoples, and their resources and their intellectual and industrial resourcefulness are more important than the initial equipment of armies and fleets. Therefore, a government that pays much attention to education and research and industrial developmental work is making the best preparation for possible wars of the future. *This fortunately produces good results if war never comes. By increasing the power and prestige of the nation, such preparation tends to prevent war, and so pays for itself twice over.*

CONCLUSION

Probably every one will grant the principle that a government should do something to educate the people, and to develop the industries and the natural resources of the country. It is only a question of the scope and extent of such work. The government has already done much, but in comparison with the needs and the opportunity it is inadequate. Cooperation of all the people in developing themselves and improving their condition and securing protection against the selfish and unfair efforts of individuals or corporations or groups, is more necessary in the modern state than formerly. And when the state contains a hundred million people and covers a continent, effective cooperation in many cases can be attained only by government assistance and leadership. Friendly governmental cooperation and constructive assistance in the industries are more welcome than regulation and repression. We must have the latter in some cases, and that is an additional reason why we should have a generous measure of the former. How far we should go experience alone can determine. But we should have the courage to face the facts, to analyze them correctly and, both in the government and in the nation, *to do as well as we know how.* We should strive for a higher and truer efficiency, for efficiency in the government, efficiency in labor, efficiency in business; and the government should not fail to do its part, which in many cases is to take the lead. If the government will cooperate with the industries in peace as earnestly and effectively as the industries cooperated with the government in war, it would be of vast benefit to the public, which pays all the costs.